

USE OF SALT-LIKE STRUCTURED SILICAS AS CHARGE CONTROL AGENTS

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CROSS-REFERENCES TO RELATED APPLICATIONS

The present invention is described in the German priority application No. DE 19957245.3, filed 27.11.1999, which is hereby incorporated by reference as is fully disclosed herein.

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BACKGROUND OF THE INVENTION

(1) FIELD OF THE INVENTION

The present invention relates to the field of charge control agents in the sense of a component which selectively influences the electrostatic charging properties in a matrix.

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In electrophotographic recording processes a "latent charge image" is produced on a photoconductor. This "latent charge image" is developed by application of an electrostatically charged toner, which is then transferred, for example, to paper, textiles, films or plastic and is fixed, for example by means of pressure, radiation, heat or the action of solvents. Typical toners are one- of two-component powder toners (also called one- or two-component developers), and special toners, such as, for example, magnetic toners, liquid toners or polymerization toners, are furthermore also in use. Polymerization toners are to be understood as meaning those toners which are formed, for example, by suspension polymerization (condensation) or emulsion polymerization and lead to improved particle properties of the toner. The term furthermore also means those toners which in principle are produced in nonaqueous dispersions.

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A measure of the toner quality is its specific charging q/m (charge per unit weight). In addition to the symbol and level of the electrostatic charging, an important quality criterion is the rapid achievement of the desired level of charge, the constancy of this charge over a relatively long activation period and the insensitivity of the toner toward climatic influences, such as temperature and

atmospheric humidity. Both positively and negatively chargeable toners are used in copiers and laser printers, depending on the type of process and apparatus.

To obtain electrophotographic toners or developers with either positive or negative charging, charge control agents are frequently added. Since toner

5 binders often show a marked dependency of the charging on the activation time, the task of a charge control agent is on the one hand to establish a symbol and level of the toner charging and on the other hand to counteract the charging drift of the toner binder and ensure constancy of the toner charging. Moreover, it is important in practice for the charge control agent to have an adequate heat
10 stability and a good dispersibility. Typical incorporation temperatures for charge control agents in the toner resins are between 100°C and 200°C using kneaders or extruders. A heat stability of 200°C is accordingly of great advantage. It is also important that the heat stability is guaranteed over a relatively long period of time (about 30 minutes) and in various binder systems.

15 For a good dispersibility, it is advantageous that the charge control agent has no wax-like properties, no tackiness and a melting or softening point of > 150°C, preferably > 200°C. Tackiness frequently leads to problems in metering into the toner formulation, and low melting or softening points can mean that no
20 homogeneous distribution is achieved on dispersing in, since the material closes together in droplet form in the carrier material.

Typical toner binders are polymerization, polyaddition and polycondensation resins, such as styrene, styrene/acrylate, styrene/butadiene, acrylate, polyester
25 and phenol/epoxide resins, as well as cycloolefin copolymers, individually or in combination, which can also comprise further constituents, for example coloring agents, such as dyestuffs and pigments, waxes or flow auxiliaries, or to which further constituents can also subsequently be added, such as finely divided silicas.

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Charge control agents can also be employed to improve the electrostatic charging of powders and coatings, in particular in powder coatings which can be sprayed triboelectrically or electrokinetically, such as are used for surface coating of objects made of, for example, metal, wood, plastic, glass, ceramic, concrete, textile material, paper or rubber. The powder coating or the powder in general acquires its electrostatic charging by one of the following two processes: In the corona process the powder coating or the powder is passed by a charged corona and charged as a result, and in the triboelectric or electrokinetic process use is made of the principle of frictional electricity. A combination of the two processes is also possible. In the spraying apparatus the powder coating or the powder acquires an electrostatic charging which is opposite to the charge of the friction partner, in general a hose or spray tube, for example made of polytetrafluoroethylene.

Epoxy resins, polyester resins containing carboxyl and hydroxyl groups and polyurethane and acrylic resins, together with the customary hardeners, are typically employed as powder coating resins. Combinations of resins are also used. Thus, for example, epoxy resins are frequently employed in combination with polyester resins containing carboxyl and hydroxyl groups.

It has furthermore been found that charge control agents can considerably improve the charging and the charge stability properties of electret materials, in particular electret fibers (DE-A-43 21 289). Typical electret materials are based on polyolefins, halogenated polyolefins, polyacrylates, polyacrylonitriles, polystyrenes or fluorine polymers, such as, for example, polyethylene, polypropylene, polytetrafluoroethylene and perfluorinated ethylene and propylene, or on polyesters, polycarbonates, polyamides, polyimides or polyether ketones, on polyarylene sulfides, in particular polyphenylenesulfides, or on polyacetals, cellulose esters or polyalkylene terephthalates, and mixtures thereof. Electret materials, in particular electret fibers, can be employed, for

example, for (extra-fine) dust filtration. The electret materials can acquire their charge by corona charging or tribo-charging.

- Charge control agents can moreover be used in electrostatic separation operations, in particular in separation operations on polymers. For instance, Y. Higashiyama et al. (J. Electrostatics 30, pp 203 - 212 (1993)) describe how polymers can be separated from one another for recycling purposes by the example of the externally applied charge control agent trimethyl-phenyl-ammonium tetraphenylborate. Without charge control agents low density polyethylene (LDPE) and high density polyethylene (HDPE) charge substantially similarly by frictional electricity. After addition of charge control agents LDPE becomes highly positively charged and HDPE highly negatively charged and they can thus be easily separated. As well as external application of charge control agents, incorporation thereof into the polymer is also possible, for example in order to shift a polymer within the triboelectric voltage series and to obtain a corresponding separating effect. Other polymers, such as, for example, polypropylene (PP) and/or polyethylene terephthalate (PET) and/or polyvinyl chloride (PVC) can also be separated from one another in this manner.
- Salt minerals can also be separated if an agent which improves the substrate-specific electrostatic charging (surface conditioning) has been added to them beforehand (A. Singewald et al., Zeitschrift für Physikal. Chem., Vol. 124, pp 223 - 248 (1981)).
- Charge control agents are furthermore employed as electroconductivity providing agents (ECPA) (JP-05-163 449) in inks for ink-jet printers and for electronic inks.

A silica fine powder which has been treated with a specific polysiloxane is known from DE-A1-39 33 166 as a developer for image-producing processes. EP-A1-0 575 805 describes a charge control agent composition which is a solids

mixture of a quaternary ammonium salt and an inorganic pigment, such as, for example, calcium sulfate or calcium silicate.

SUMMARY OF THE INVENTION

- 5 The object of the present invention was to discover active and ecotoxicologically tolerated charge control agents which show, in particular, a high rapid charging. They should furthermore be readily dispersible without decomposition in various toner binders appropriate in practice, such as polyesters, polystyrene/acrylates or polystyrene-butadienes/epoxide resins as well as cycloolefin copolymers.
- 10 Their action should furthermore be largely independent of the resin/carrier combination, in order to open up a broad application. They should also be readily dispersible without decomposition in the usual powder coating binders and electret materials, such as, for example, polyester (PES), epoxide, PES-epoxy hybrid, polyurethane, acrylic systems and polypropylenes.
- 15 In respect of their electrostatic efficiency, the charge control agents should already be active at the lowest possible concentration (1% or less) and should not lose this efficiency in combination with carbon black or other coloring agents. It is known of coloring agents that in some cases they can influence the
- 20 triboelectric charging of toners for a long time.

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- Surprisingly, it has now been found that salt-like structured silicates described below have advantageous charge control properties and high heat stabilities, the charge control property being lost neither by combination with carbon black nor
- 25 with other coloring agents. The compounds are moreover readily compatible with the customary toner, powder coating and electret binders and can easily be dispersed. The resin-carrier systems which usually have a negative control can furthermore also be effectively charged positively.

- 30 DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to the use of salt-like structured silicates in which the cation is NH_4^+ , H_3O^+ , an alkali metal, alkaline earth metal, earth metal or transition metal ion or a low molecular weight organic cation or a combination thereof and the anion is an island, cyclic, group, chain, ribbon, laminar or matrix silicate or a combination thereof as a charge control agent in electrophotographic toners and developers, in powder coatings and electret materials and in electrostatic separation processes.

According to the customary definition, the structured silicates mentioned are based on the following empirical formulae:

for island silicates $[\text{SiO}_4]^{4-}$, for group silicates $[\text{Si}_2\text{O}_7]^{6-}$, for cyclic silicates $[\text{SiO}_3]_n^{2-}$, for chain silicates $[\text{SiO}_3]_m^{2-}$, for ribbon silicates $[\text{Si}_4\text{O}_{11}]_m^{6-}$, for laminar silicates $[\text{Si}_2\text{O}_5]_m^{2-}$ and for matrix silicates $[\text{Al}_a\text{Si}_{1-a}\text{O}_2]_m^{a-}$, in which $n = 3, 4, 6$ or 8 , m is an integer and is ≥ 1 and $0 < a < 1$. Structured silicates are frequently accompanied by further low molecular weight anions, such as, for example, OH^- , F^- , Cl^- , Br^- , I^- , BO_3^{3-} , $\text{BO}_2(\text{OH})^{2-}$, $\text{BO}(\text{OH})_2^-$, HCO_3^- , CO_3^{2-} , NO_3^- , HSO_4^- , SO_4^{2-} , H_2PO_4^- , HPO_4^{2-} , PO_4^{3-} , HS^- or S^{2-} .

Furthermore, in structured silicates some individual Si atoms can be replaced by other atoms, such as, for example, Al, B, P or Be ("aluminosilicates",

"borosilicates" and the like). Naturally occurring or synthetically prepared structured silicates are furthermore distinguished in that they comprise one or more different cations, which are often easily exchangeable, such as, for example, Na^+ , K^+ , Mg^{2+} and Ca^{2+} , and, for example, can be replaced by organic ions, whereupon their chemical and physical properties can change. The silicate changed in this way can be, for example, highly hydrophobized and therefore readily processable in non-polar media. In the case of laminar silicates, the individual silicate platelet is enveloped by the organic ions in this manner. These coated molecules can assemble together over their surfaces to give lamellae. If an excess of organic ions is used, these can also additionally be embedded between the lamellae.

Preferred structured silicates in the sense of the present invention are
montmorillonite, bentonite, hectorite, kaolinite, serpentine, talc, pyrophyllite,
mica, phlogopite, biotite, muscovite, paragonite, vermiculite, beidellite,
xantophyllite, margarite, feldspar, zeolite, wollastonite, actinolite, amosite,
5 crocidolite, sillimanite, nontronite, smectite, sepiolite, saponite, faujasite,
permutite and sasil.

Examples of naturally occurring structured silicates are:

- Be₂[SiO₄] phenacite, forsterite Mg₂[SiO₄], olivine (Mg,Fe)₂[SiO₄], fayalite
10 Fe₂[SiO₄], granates M₂^{III}M₃^{II} [SiO₄]₃ (M^{II} = Mg²⁺, Ca²⁺, Fe²⁺, Mn²⁺, M^{III} = Al³⁺, Fe³⁺,
Cr³⁺), zirconium Zr[SiO₄], thortveitite Sc₂[Si₂O₇], barysilite Pb₃[Si₂O₇],
hemimorphite Zn₄(OH)₂ [Si₂O₇], α-wollastonite Ca₃ [Si₃O₉], benitoite BaTi [Si₃O₉],
beryl Al₂Be₃ [Si₆O₁₈], diopside Cu₆ [Si₆O₁₈]•6 H₂O, dravite
Na{Mg₃Al₆(OH)₄(BO₃)₃[Si₆O₁₈]}, Schörl
15 Na{Fe₃^{II}(Al,Fe^{III})₆(OH)₄(BO₃)₃[Si₆O₁₈]}, β-wollastonite Ca[SiO₃], enstatite
Mg[SiO₃], diopside CaMg[SiO₃]₂, spodumen LiAl[SiO₃]₂, pyroxenes, amphiboles,
tremolite Ca₂Mg₅(OH)₂[Si₄O₁₁]₂, anthophyllite (Mg,Fe^{II})₇(OH)₂[Si₄O₁₁]₂, actinolite
(Ca,Na)₂(Fe,Mg,Al)₅(OH)₂[(Si,Al)₄O₁₁]₂, amosite (Fe^{II}Mg,Al)₇(OH)₂[(Si,Al)₄O₁₁]₂,
crocidolite Na₂(Fe^{II},Mg)₃(Fe^{III})₂[(Si,Al)₄O₁₁]₂, sillimanite Al[AlSiO₅], mullite,
20 krauskopfite, rhodonite, stokesite, serpentine Mg₃(OH)₄[Si₂O₅], kaolinite
Al₂(OH)₄[Si₂O₅], halloysite Al₂(OH)₄[Si₂O₅]•2 H₂O, kaolin, petalite LiAl[Si₂O₅]₂,
apophyllite Ca₄K(F)[Si₂O₅]₄, gillespite BaFe[Si₂O₅]₂, anorthite Ca₂[SiAlO₄]₄,
hexacelsian Ba₂[SiAlO₄]₄, talc Mg₃(OH)₂[Si₂O₅]₂, pyrophyllite Al₂(OH)₂[Si₂O₅]₂;
kanemite NaH[Si₂O₅];
25 laminar aluminosilicates: mica, phlogopite K{Mg₃(OH,F)₂[AlSi₃O₁₀]}, biotite
K{(Mg,Fe,Mn)₃(OH,F)₂[AlSi₃O₁₀]}, paragonite Na{Al₂(OH,F)₂[AlSi₃O₁₀]},
muscovite K{Al₂(OH,F)₂[AlSi₃O₁₀]}, fluoromuscovite K{Al₂F₂[AlSi₃O₁₀]}, micas of
the composition (K,H₃O)_y{Mg₃(OH)₂[Si_{4-y}Al_yO₁₀]} or (K,H₃O)_y{Al₂(OH)₂[Si_{4-y}
Al_yO₁₀]}, in which y = 0.7 to 0.9, brittle micas, for example xantophyllite
30 Ca{Mg₃(OH)₂[Al₂Si₂O₁₀]} or margarite Ca{Al₂(OH)₂[Al₂Si₂O₁₀]}, mica-like silicates,





$(\text{Ca}, \text{Na})_{0.33}\{(\text{Mg}, \text{Fe}^{II})_3(\text{OH})_2[\text{Al}_{0.33}\text{Si}_{3.67}\text{O}_{10}]\}$, laponite or hectorite $\text{Na}_{0.33}\{(\text{Mg}, \text{Li})_3(\text{OH}, \text{F})_2[\text{Si}_4\text{O}_{10}]\}$, feldspars, such as, for example, $\text{K}[\text{AlSi}_3\text{O}_8]$, $\text{Na}[\text{AlSi}_3\text{O}_8]$, $\text{Ca}[\text{Al}_2\text{Si}_2\text{O}_8]$, $\text{Na}[\text{AlSiO}_4]$, $\text{K}[\text{AlSi}_2\text{O}_6]$;

10 $\text{Na}_2[\text{Al}_2\text{Si}_{10}\text{O}_{24}] \cdot 6 \text{H}_2\text{O}$, natrolite $\text{Na}_2[\text{Al}_2\text{Si}_3\text{O}_{10}] \cdot 2 \text{H}_2\text{O}$, permutite, sasil, zeolite A
 $\text{Na}_{12}[\text{Al}_{12}\text{Si}_{12}\text{O}_{24}] \cdot 27 \text{H}_2\text{O}$, zeolite X $\text{Na}_{43}[\text{Al}_{43}\text{Si}_{83}\text{O}_{126}] \cdot 132 \text{H}_2\text{O}$, zeolite Y
 $\text{Na}_{28}[\text{Al}_{28}\text{Si}_{68}\text{O}_{96}] \cdot 125 \text{H}_2\text{O}$, and other matrix aluminosilicates, such as, for
example, ultramarines or lasurite.

15 The ionic structured silicate can be either of natural origin, for example contained in or alongside a naturally occurring mineral or rock, such as, for example, bentonite or montmorillonite, or a synthetically prepared structured silicate, for example a magnesium hydrosilicate or a synthetic hectorite (for example DE-A-2718 576) or $\text{Na}_2[\text{Si}_2\text{O}_5]$.

20 In the case of a naturally occurring structured silicate, the geographical deposit can have an influence on the chemical and physical properties of the material. Ionic structured silicates, which in nature are often accompanied by other minerals or rocks (for example quartz), can be worked up by mechanical or chemical process steps, for example very finely ground, purified by or separated
25 from other concomitant substances, pH-treated, dehydrated, pressure-treated, heat-treated or treated by oxidation or reduction or with chemical auxiliaries.

Trade names for structured silicates which can be employed for the purposes of the invention are:

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®Laundrosil, ®Bionit, ®Edasil, ®Agriben, ®Tixogel, ®Optibent, ®Optigel, ®Airsec, ®Albion Kaolin, ®Biokat's, ®Container Dri, ®Desi Pak, ®Ivyblock, ®Montigel, ®Detbuild, ®Bleach, ®Volclay, ®Bentobrite, ®Polargel and ®Suspengel.

- 5 Structured silicates which are also used in other sectors, such as, for example, bleaching bentonite, paper bentonites, foundry bentonites, ceramic bentonites, desiccants, thickeners, antisedimentation agents, catalysts and water softening/water treatment and purification agents, can also be employed in the sense of the invention.

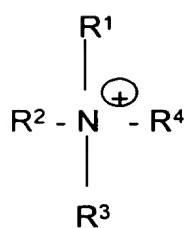
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Possible metal cations of the structured silicates used according to the invention are, for example

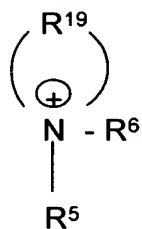
- 15 Li^+ , Na^+ , K^+ , Rb^+ , Cs^+ , Be^{2+} , Mg^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} , Al^{3+} , TiO^{2+} , ZrO^{2+} , Zn^{2+} , Fe^{2+} , Fe^{3+} , Sn^{2+} , Sn^{4+} , Pb^{2+} , Pb^{4+} , Cr^{3+} , Mn^{4+} , Mn^{2+} , Co^{2+} , Co^{3+} , Cu^{2+} , Sc^{3+} , Ti^{4+} , Zr^{4+} , V^{5+} , Y^{3+} , Ni^{2+} , Mo^{6+} and W^{6+} .

The low molecular weight organic cations are preferably substituted ammonium, phosphonium, thionium or triphenylcarbonium ions or a cationic metal complex.

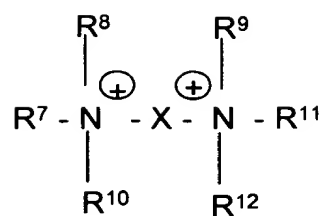
- 20 Preferred ions are low molecular weight, that is to say nonpolymeric, ammonium ions of the formulae (a) - (j):



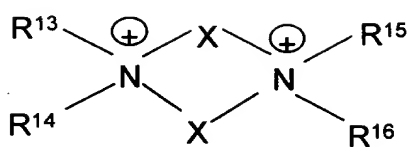
(a)



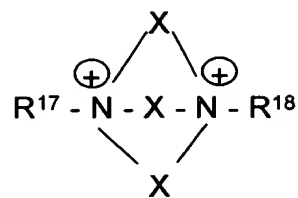
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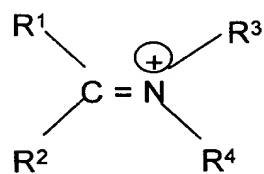
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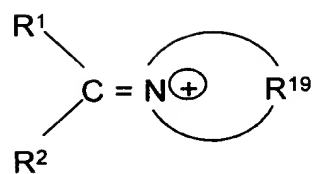
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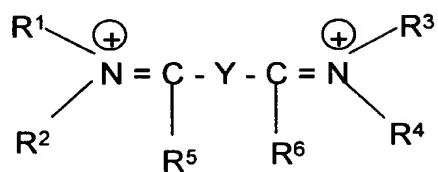
(e)



(f)

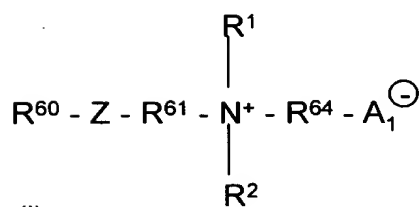


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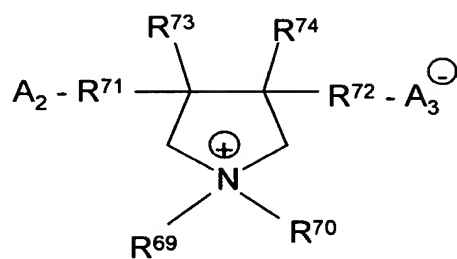


(h)

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(i)



(j)

in which

R^1 to R^{18} are identical or different and represent hydrogen, CN, $(CH_2)_{1-18}CN$, halogen, for example F, Cl or Br, branched or unbranched C_1 - C_{32} -alkyl, mono- or polyunsaturated C_2 - C_{32} -alkenyl, in particular C_2 - C_{22} -alkenyl, such as, for

5 example tallow fatty alkyl; C_1 - C_{22} -alkoxy, C_1 - C_{22} -hydroxyalkyl, C_1 - C_{22} -halogenoalkyl, C_2 - C_{22} -halogenoalkenyl, C_1 - C_{22} -aminoalkyl, $(C_1$ - $C_{12})$ -trialkyl-ammonium- $(C_1$ - $C_{22})$ -alkyl;

$(C_1$ - $C_{22})$ -alkylene- $(C=O)O$ - $(C_1$ - $C_{32})$ alkyl, $(C_1$ - $C_{22})$ -alkylene- $(C=O)O$ -aryl, $(C_1$ - $C_{22})$ -alkylene- $(C=O)NH$ - $(C_1$ - $C_{32})$ alkyl, $(C_1$ - $C_{22})$ -alkylene- $(C=O)NH$ -aryl, $(C_1$ - $C_{22})$ -alkylene- $O(C=O)$ - $(C_1$ - $C_{32})$ alkyl, in particular $(C_1$ - $C_{18})$ -alkylene- $O(CO)$ - $(C_1$ - $C_{32})$ alkyl, $(C_1$ - $C_{22})$ -alkylene- $O(CO)$ aryl, $(C_1$ - $C_{22})$ -alkylene- $NH(C=O)$ - $(C_1$ - $C_{32})$ alkyl, $(C_1$ - $C_{22})$ -alkylene- $NHCO$ -aryl,

wherein



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can be inserted into the acid ester or acid amide bonds;

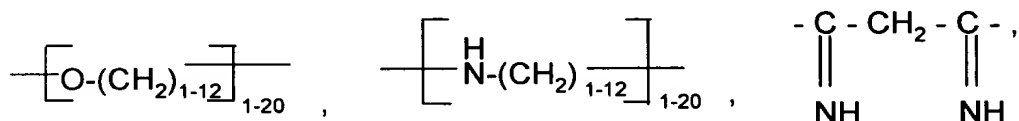
$[(C_1$ - $C_{12})$ -alkylene- O] $_{1-100}$ -H; aryl, $(C_1$ - $C_{18})$ -alkylenearyl, $-(O-SiR'_2)_{1-32}-O-SiR'_3$, in which R' has the meaning C_1 - C_{12} -alkyl, phenyl, benzyl or C_1 - C_{12} -alkoxy; heterocyclyl, C_1 - C_{18} -alkylene-heterocyclyl;

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R^{19} represents C_4 - C_{11} -alkylene, $-(C_2H_4-O)_{1-17}-(CH_2)_{1-2}$, $-(C_2H_4-NR)_{1-17}-(CH_2)_{1-2}$, in which R is hydrogen or C_1 - C_{12} -alkyl;

X has the meaning of Y and $-CO-CH_2-CO-$,

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heteroaryl with 1, 2, 3 or 4 heteroatoms from the group consisting of N, O and/or S,

R^{61} and R^{64} represent $-(CH_2)_{1-18}-$, C_1-C_{12} -alkylene- C_6-C_{10} -arylene, C_6-C_{10} -arylene, C_0-C_{12} -alkylene-heterocyclyl;

5 Z represents $-NH-$ or $-O-$;

~~A_1^σ and A_3^σ represent $-COO^\sigma$, $-SO_3^\sigma$, $-OSO_3^\sigma$, $-SO_2^\sigma$, $-COS^\sigma$ or $-CS_2^\sigma$;~~

A_2 represents $-SO_2Na$, $-SO_3Na$, $-SO_2H$, $-SO_3H$ or hydrogen;

R^{69} and R^{70} independently of one another represent hydrogen, C_1-C_{32} -alkyl, in which the alkyl chain can contain one or more of the groups $-NH-CO-$, $-CO-NH-$,

10 $-CO-O-$ or $-O-CO-$; C_1-C_{18} -alkylene-aryl, C_0-C_{18} -alkylene-heterocyclyl, C_1-C_{18} -hydroxyalkyl, C_1-C_{18} -halogenoalkyl, aryl, $-(CH_2)_3-SO_3^\sigma$,

~~$-CH_2-CH-CH_2-SO_3^\sigma$, $-CH_2-CH-CH_2-SO_3^\sigma$;~~

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~~SO_2^σ~~

~~SO_3^σ~~

R^{71} and R^{72} represent $-(CH_2)_{1-12}-$; and

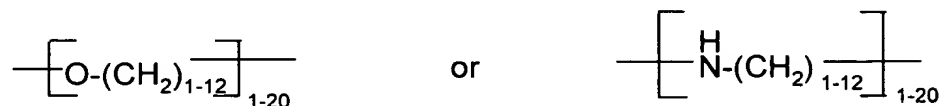
R^{73} and R^{74} represent hydrogen or C_1-C_{22} -alkyl.

- 20 Unless described otherwise, "aryl" in the preceding and following definitions preferably represents C_6-C_{18} -aryl, in particular phenyl or naphthyl, "heterocyclyl" preferably represents a saturated, unsaturated or aromatic, five- to seven-membered ring with 1, 2, 3 or 4 heteroatoms from the group consisting of N, O and/or S, for example pyridyl, imidazolyl, triazinyl, pyridazyl, pyrimidinyl,
- 25 pyrazinyl, piperidinyl, morpholinyl, purinyl, tetrazonyl, or pyrrolyl. The aryl and heterocyclyl radicals can furthermore be mono- or polysubstituted, for example 2, 3, 4 or 5 times, on carbon atoms or heteroatoms by C_1-C_{12} -alkyl, C_1-C_4 -alkenyl, C_1-C_4 -alkoxy, hydroxy- (C_1-C_4) alkyl, amino- (C_1-C_4) alkyl, C_1-C_4 -alkylimino, carboxyl, hydroxyl, amino, nitro, cyano, halogen, C_1-C_{12} -acyl, C_1-C_4 -
- 30 halogenoalkyl, C_1-C_4 -alkylcarbonyl, C_1-C_4 -alkylcarbonyloxy, C_1-C_4 -

alkoxycarbonyl, C₁-C₄-alkylaminocarbonyl, C₁-C₄-alkylcarbonylimino, C₆-C₁₀-arylcarbonyl, aminocarbonyl, aminosulfonyl, C₁-C₄-alkylaminosulfonyl, phenyl, naphthyl or heteroaryl, for example pyridyl, imidazolyl, triazinyl or pyrimidinyl.

- ~~5/12/14~~ Heterocyclic ammonium ions which are furthermore preferred are aliphatic or aromatic 5- to 12-membered heterocyclic radicals with 1, 2, 3 or 4 N, O and/or S atoms belonging to rings, it being possible for 2 to 8 rings to be fused, in particular pyridinium, pyridazinium, pyrimidinium, pyrazinium, purinium, tetraazaporphyrinium, piperidinium, morpholinium, tetrazonium.
- 10 Further suitable heterocyclic radicals are, for example, pyrrolium, pyrazolium, imidazolium, benzimidazolium, imidazolonium, benzimidazolonium, imidazolinium, benzimidazolinium, alkylpyrrolidino-benzimidazolonium, indolium, isoindolium, indolizinium, pyrrolizidinium, carbazolium, indazolium, quinolinium, isoquinolinium, pyrindinium, acridinium, phenanthridinium, lilolinium, julolinium,
- 15 matridinium, cinnolinium, quinazolinium, quinoxalinium, perimidinium, phenazonium, phenazinium, 1,10-phenanthroline, β -carbolinium, quinolizinium, 1,8-naphthyldrinium, pteridinium, quinuclidinium, conidinium, hypoxanthinium, adeninium, xanthinium, isoxanthinium, heteroxanthinium, isoadeninium, guaninium, epiguaninium, theophyllinium,
- 20 paraxanthinium, theobrominium, caffeine, isocaffeine, trihydroxypurinium, porphyrinium, tetraazaphorphyrinium, metal-complexed tetraazaphorphyrinium (for example with Mg, Ca, Sr, Ba, Al, Mn, Fe, Co, Cu, Zr, Ti, Cr, Ni or Zn), bis-tetrazonium, phenoxazinium and aminoxanthenium, and derivatives of the cations mentioned mono- or polysubstituted on carbon atoms or heteroatoms, it
- 25 being possible for the substituents to be, independently of one another, carboxyl, hydroxyl,
- C₁-C₂₂-alkoxy, C₁-C₃₂-alkyl, in particular C₁-C₂₂-alkyl, C₂-C₂₂-alkenyl, hydroxy-(C₁-C₂₂)-alkyl, amino, aminoalkyl, C₁-C₁₈-iminoalkyl, alkylamido, alkylcarbonyloxy, alkyloxycarbonyl, (C₁-C₂₂)-alkylene-(C=O)O-(C₁-C₃₂)alkyl, (C₁-
- 30 C₂₂)-alkylene-(C=O)O-aryl, (C₁-C₂₂)alkylene-(C=O)NH-(C₁-C₃₂)alkyl, (C₁-C₂₂)-alkylene-(C=O)NH-aryl,

(C₁-C₂₂)-alkylene-O(CO)-(C₁-C₃₂)alkyl, (C₁-C₂₂)alkylene-O(CO)-aryl,
(C₁-C₂₂)alkylene-NH(C=O)-(C₁-C₃₂)alkyl, (C₁-C₂₂)-alkylene-NHCO-aryl; wherein

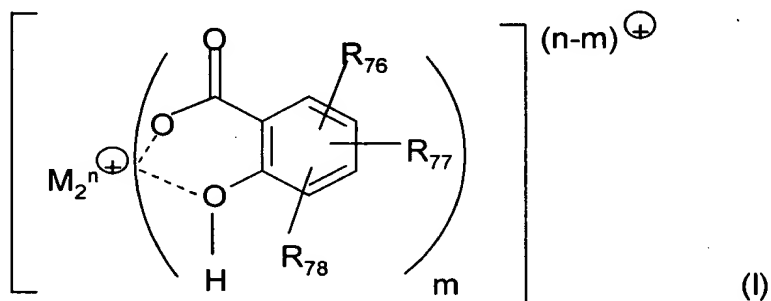
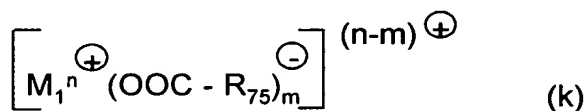


can be inserted into the acid ester or acid amide bonds;

- 5 nitro, cyano, halogen, poly(C₁-C₁₂-alkylene oxide) or C₁-C₂₂-acyl,
in particular N- or C-(C₁-C₂₂)-alkylated heterocyclic radicals, as mentioned
above, for example N-(C₁-C₂₀)alkyl-pyridinium or 1-methyl-1-stearyl-amidoethyl-2-
stearyl imidazolinium.
- 10 Ions of the formulae (a) - (j) which are of particular interest are those in which
R¹ to R¹⁸ denote hydrogen, CN, CH₂-CN, CF₃, C₁-C₂₂-alkyl, for example coconut
alkyl, cetyl, stearyl or hydrogenated tallow fatty alkyl; C₂-C₂₂-alkenyl, in particular
C₂-C₁₈-alkenyl, C₁-C₁₈-alkoxy, C₁-C₁₈-hydroxy-alkyl, C₁-C₁₈-halogenoalkyl, C₂-
C₁₈-halogenoalkenyl, in which halogen preferably denotes F or Cl, C₁-C₁₈-
15 aminoalkyl, (C₁-C₆)-trialkylammonium-(C₁-C₁₈)-alkyl, (C₁-C₁₈)-alkylene-O(C=O)-
(C₁-C₂₂)alkyl, (C₁-C₁₈)-alkylene-O(C=O)-phenyl, (C₁-C₁₈)-alkylene-NHCO-(C₁-
C₂₂)alkyl, (C₁-C₁₈)-alkylene-NHCO-phenyl, (C₁-C₁₈)-alkylene-(C=O)O-(C₁-
C₂₂)alkyl, (C₁-C₁₈)-alkylene-(C=O)O-phenyl, (C₁-C₁₈)alkylene-(C=O)NH-
(C₁-C₂₂)alkyl, (C₁-C₁₈)-alkylene-CONH-phenyl, benzyl, phenyl, naphthyl or C₁-
20 C₁₂-alkylene-heterocyclyl;
R¹⁹ denotes C₄-C₅-alkylene, -(C₂H₄-O)₁₋₉-(CH₂)₁₋₂- or
-(C₂H₄-NH)₁₋₉-(CH₂)₁₋₂;
R⁶⁰ denotes C₁-C₁₈-acyl, C₁-C₁₈-alkyl, C₂-C₁₈-alkenyl, C₁-C₁₂-alkylene-phenyl,
C₁-C₁₈-alkylenepyridyl, phenyl or pyridyl;
- 25 R⁶¹ and R⁶⁴ denote -(CH₂)₁₋₁₂-, C₁-C₈-alkylenephenylene, phenylene or C₁-C₈-
alkylenepyridylene or -piperidylene;
R⁷¹ and R⁷² denote -(CH₂)₁₋₈ and
R⁷³ and R⁷⁴ denote hydrogen or (C₁-C₁₈)-alkyl.

Preferred low molecular weight organic cations are furthermore cationic metal complexes, such as metal carboxylates, metal salicylates, metal sulfonates, 1:1 metal-azo complexes or metal dithiocarbamates, in which metal is preferably Al, Mg, Ca, Sr, Ba, TiO, VO, Cr, V, Ti, Zr, Sc, Mn, Fe, Co, Ni, Cu, Zn and ZrO and the metal complex optionally contains one or more further ligands.

Preferred metal carboxylates and salicylates are those of the formulae (k) and (l)



in which $n = 2, 3$ or 4 ;

$m = 1, 2$ or 3 , but is always less than n ;

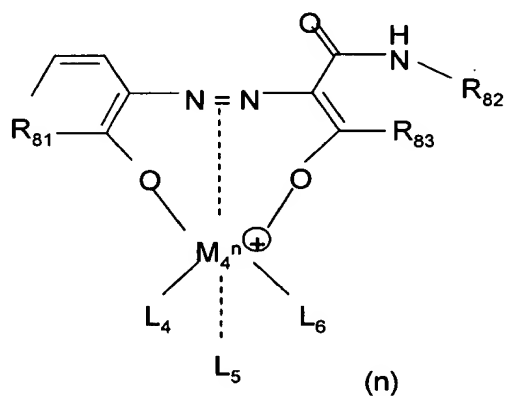
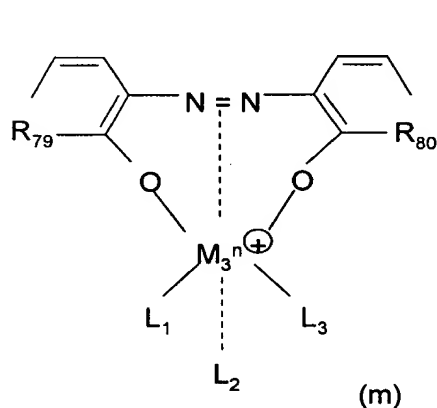
M_1^{np} and M_2^{np} independently of one another are a metal cation of the main group or transition metals, for example represent B, Al, Mg, Ca, Sr, Ba, Sc, V, Ti, Zr, TiO, Cr, Mn, Fe, Co, Ni, Cu, Zn or ZrO,

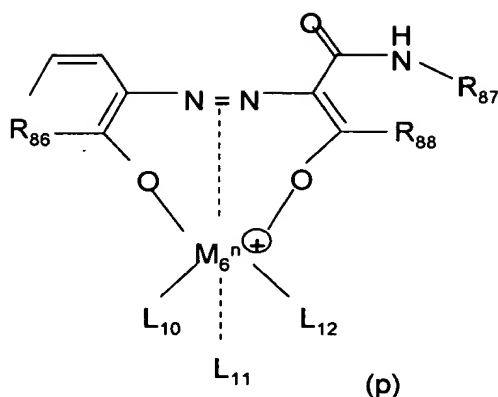
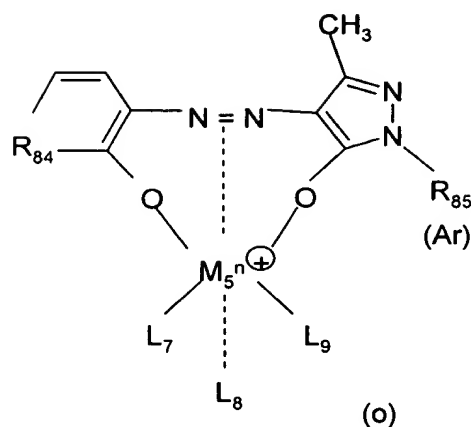
R_{75} can be $\text{C}_1\text{-C}_{32}$ -alkyl (linear or branched), $\text{C}_1\text{-C}_{22}$ -halogenoalkyl, $\text{C}_1\text{-C}_{18}$ -hydroxyalkyl, $\text{C}_1\text{-C}_{18}$ -aminoalkyl, $\text{C}_1\text{-C}_{18}$ -ammoniumalkyl, $\text{C}_1\text{-C}_{18}$ -alkylene-aryl, $\text{C}_1\text{-C}_{18}$ -alkylene-heterocyclyl, aryl or heterocyclyl, as defined above; and R_{76} to R_{78} independently of one another can be $\text{C}_1\text{-C}_{12}$ -alkyl (linear or branched), $\text{C}_1\text{-C}_4$ -alkoxy, hydroxyl, carboxyl, $\text{C}_1\text{-C}_4$ -alkenyl, hydroxy- $(\text{C}_1\text{-C}_4)$ -alkyl, amino, $(\text{C}_1\text{-C}_4)$ -aminoalkyl, nitro, cyano, halogen, $\text{C}_1\text{-C}_{12}$ -acyl, $\text{C}_1\text{-C}_4$ -iminoalkyl, $\text{C}_1\text{-C}_4$ -halogenoalkyl, aryl or heterocyclyl, as defined above.

Analogous cationic complexes or salts of the abovementioned metals with ligands, such as α -hydroxyphenol, α -aminoaniline, α -hydroxyaniline, α -aminobenzoic acid, quinoline, 1,8-diaminonaphthalene, 1,4,5,8-tetraamino-naphthalene, 1,8-dihydroxynaphthalene or 1,4,5,8-tetrahydroxynaphthalene, are furthermore suitable.

Analogous cationic complexes or salts of the abovementioned metals with ligands or anions, such as, for example, α,α -dipyridyl, ethylenediamine, diethylenetriamine, triethylenetetraamine, acetylacetonate, ortho-phenanthroline, benzoyl ketones, ethylenedi(biguanidine), biguanidine or dimethylglyoxime, are furthermore suitable.

Preferred 1:1 metal-azo complexes are those of the formulae (m) - (p)





wherein M_3^{n+} to M_6^{n+} have one of the meanings of M_1^{n+} or M_2^{n+} ,

R_{79} , R_{80} , R_{81} , R_{84} and R_{86} independently of one another are an atomic group,

5 which can optionally carry substituents, needed to complete a mono- or dinuclear ring system of aromatic character,

R_{82} and R_{87} independently of one another are a phenyl radical which optionally carries substituents or a (C_1-C_{12}) -alkyl or (C_1-C_2) -alkoxy- (C_2-C_8) -alkyl radical,

R_{83} , R_{85} and R_{88} independently of one another are C_1-C_{12} -alkyl or phenyl,

10 optionally carrying substituents,

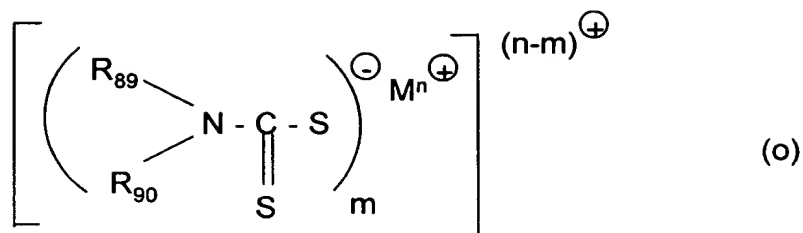
and the ligands L_1 to L_{12} independently of one another can be H_2O , OH^- , NH_3 , F^- , Cl^- , Br^- , I^- , NO_3^- , HSO_4^- , SO_4^{2-} , $H_2PO_4^-$, HPO_4^{2-} , PO_4^{3-} , BO_3^{3-} , $BO_2(OH)^{2-}$,

$BO(OH)_2^-$, HCO_3^- , CO_3^{2-} , H_2S , HS^- , S^{2-} , oxalate, citrate, formate, acetate, propionate, fumarate, maleate, tartrate,

15 C_1-C_4 -alkylsulfonate, tauride, methyltauride, sarcoside, methylsarcoside, lactate and other low molecular weight carboxylates and sulfonates.

Cationic complexes or salts which are furthermore suitable are those of the abovementioned metals with dithiocarbamate ligands according to the formula

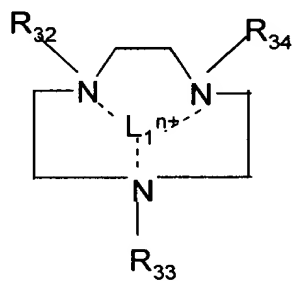
20 (o)



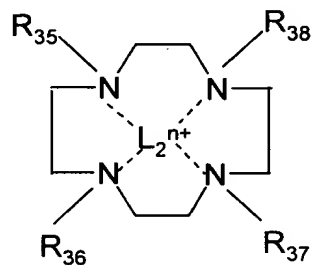
in which the radicals R_{89} and R_{90} independently of one another have one of the meanings of R_1 and m and n are a number from 1 to 4, where $n > m$.

5

Cations which are furthermore suitable are triaza-cyclononanium or tetraaza-cyclododecanium cations of the formulae (p) and (q)



(p)



(q)

10

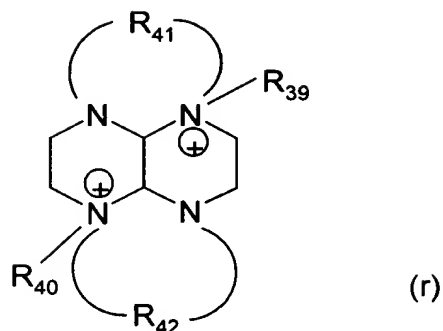
in which R_{32} to R_{38} independently of one another can be H, C_1 - C_{32} -alkyl, C_2 - C_{18} -alkenyl, C_1 - C_{18} -halogenoalkyl, C_1 - C_{18} -alkoxy, C_1 - C_{18} -hydroxyalkyl,

(C_1 - C_8)-alkylene-(C_6 - C_{14})-aryl or (C_1 - C_{10})-alkyleneheteroaryl, for example (C_1 - C_{10})-alkylene-pyridyl, n represents a number between 1 and 4 and L_1 and L_2

15 represent a low molecular weight cation, for example hydrogen or a main group or transition metal, such as Li, Na, K, Rb, Cs, Be, Mg, Ca, Sr, Ba, Al, TiO, ZrO, Mn, VO, Fe, Co, Cu, Zn, Cr, Ni, Mo or W.

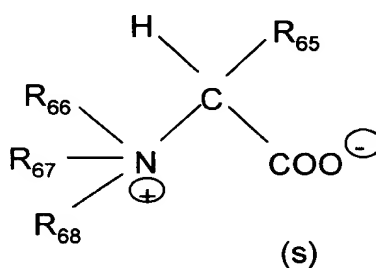
Ammonium cations which are furthermore suitable are those of the general

20 formula (r)



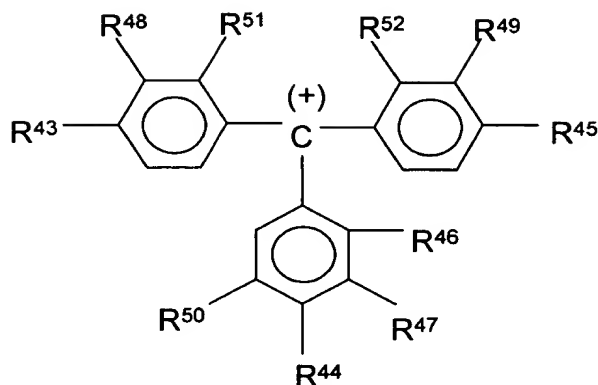
in which R_{39} and R_{40} independently of one another have one of the meanings of R_{32} ; and R_{41} and R_{42} represent $(-CH_2-)_n$, where $n = 2$ to 9 .

- 5 Amino acids which are furthermore suitable are those of the general formula (s)



- in which the radicals R_{66} to R_{68} independently of one another can be hydrogen,
- 10 C_1 - C_{22} -alkyl, C_1 - C_{18} -hydroxyalkyl, $(C_1$ - $C_{22})$ -halogenoalkyl, $(C_1$ - $C_{18})$ -alkylenearyl, for example benzyl, $(C_1$ - $C_{18})$ -alkyleneheteroaryl, $(C_6$ - $C_{10})$ -aryl, heteroaryl, for example pyridyl, heterocycl, for example morpholinyl or piperidinyl, or $(C_1$ - $C_8)$ -alkyleneheterocycl and
- R_{65} can be hydrogen, C_1 - C_{18} -alkyl, C_1 - C_{18} -hydroxyalkyl, C_1 - C_{18} -thioalkyl, C_1 - C_{18} -aminoalkyl, C_1 - C_{18} -carboxyalkyl, C_1 - C_{18} -alkylenearyl, for example benzyl, C_1 - C_{18} -alkyleneheteroaryl, C_1 - C_{18} -alkyleneheterocycl C_6 - C_{10} -aryl, $(C_4$ - $C_{10})$ -heteroaryl, $(C_4$ - $C_{10})$ -heterocycl, for example morpholinyl or piperidinyl, C_1 - C_{22} -acyl, C_1 - C_{18} -halogenalkyl or cyano.
- 15

Triphenylmethane cations which are furthermore suitable are those of the formula



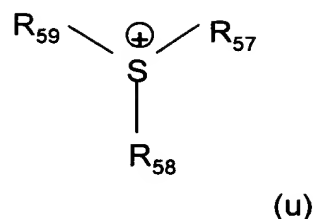
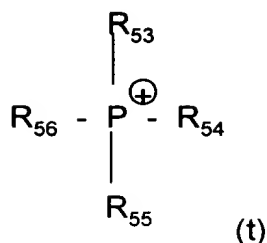
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in which

- R^{43} and R^{45} are identical or different and denote $-NH_2$, a mono- or dialkylamino group, the alkyl groups of which have 1 to 4, preferably 1 or 2, carbon atoms, a mono- or di-omega-hydroxyalkylamino group, the alkyl groups of which have 2 to 4, preferably 2, carbon atoms, an optionally N-(C₁-C₄)alkyl-substituted phenyl- or phenalkylamino group, the alkyl of which has 1 to 4, preferably 1 or 2, carbon atoms and the phenyl nucleus of which can carry one or two of the radicals, methyl, ethyl, methoxy, ethoxy and sulfo,
- R^{44} is hydrogen or has one of the meanings given for R^{43} and R^{45} ,
- R^{46} and R^{47} denote hydrogen, halogen, preferably chlorine, or a sulfonic acid group, or R^{46} forms a fused-on phenyl ring together with R^{47} ,
- R^{48} , R^{49} , R^{51} and R^{52} each denote hydrogen or an alkyl radical having 1 or 2 carbon atoms, preferably methyl, and
- R^{50} is hydrogen or halogen, preferably chlorine.

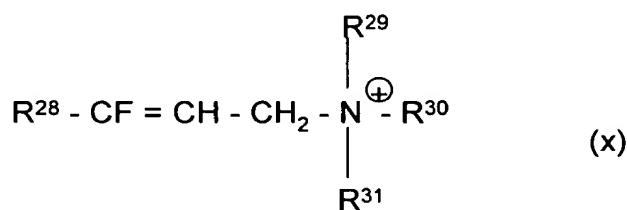
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Phosphonium and thionium cations which are furthermore suitable are those of the formulae (t) and (u)



in which R_{53} to R_{59} independently of one another are C_1 - C_{18} -alkyl, C_2 - C_{18} -alkenyl, C_1 - C_{18} -alkoxy, C_1 - C_{18} -hydroxyalkyl, $(C_1$ - C_8)alkylene- $(C_6$ - $C_{10})$ aryl, for example benzyl, alkyleneheteroaryl, C_6 - C_{10} -aryl or heteroaryl, for example pyridinyl.

Fluorinated ammonium ions of the formula (x)



in which

R^{28} denotes perfluorinated alkyl having 5 to 11 carbon atoms and R^{29} , R^{30} and R^{31} are identical or different and denote alkyl having 1 to 5 carbon atoms, preferably 1 or 2 carbon atoms, are particularly preferred.

The structured silicates containing a low molecular weight organic cation can be prepared by bringing together one or more naturally occurring or synthetic structured silicates with a salt containing the low molecular weight organic cation, for example the corresponding chloride, bromide, iodide or methylsulfate, in aqueous suspension, expediently at a pH of between 0 and 14, preferably between 1 and 13, expediently at a temperature of 0 to 160°C, preferably 5 to 140°C, expediently under a pressure of 1 to 20 bar, for 5 minutes to 48 hours, preferably 10 minutes to 24 hours, in a molar ratio of organic cation :

silicate of 1:100 to 10:1, preferably 1:20 to 3:1. It is advantageous to predisperse the structured silicate in water for between ½ and 48 hours, preferably between 1 and 24 hours, for example at a temperature of 5 to 100°C. It is furthermore advantageous to adjust the salt of the organic cation and/or the aqueous suspension of the structured silicate(s) to a pH of between 1 and 12, preferably 5 and 10, before the reaction in an aqueous medium.

A salt-like structured silicate in which the silicate is hectorite, beidellite, illite, muscovite, xantophyllite, margarite, sepiolite, saponite, mica, feldspar, nontronite, montmorillonite, smectite, bentonite, faujasite, zeolite A, X or Y, permutite, sasil or a combination thereof; and the cation is an ion of the formula (x) described above is novel and the present invention likewise relates to it. These novel compounds can be prepared as described above. These compounds can surprisingly show a charge assistant effect in the medium employed, in particular can achieve an assisting anti-offset action (better detachment of the toner from moving parts of the printing machinery which come into contact with the toner, for example photoconductors, deflection rollers).

The salts, used according to the invention, of ionic structured silicates can be matched accurately to the particular resin/toner system. Another technical advantage of these compounds is that they are inert toward the various binder systems and can thus be employed for diverse uses, it being of particular importance that they are not dissolved in the polymer matrix but are present as small, very finely divided solids. They furthermore show high and usually constant charge control properties and good heat stabilities. The structured silicates employed according to the invention are furthermore free-flowing and have a good dispersibility.

Dispersion means the distribution of one substance in another, in the sense of the invention the distribution of a charge control agent in the toner binder, powder coating binder or electret material.

It is known that crystalline substances in their coarsest form exist as agglomerates. To achieve a homogeneous distribution in the binder, these must be divided into smaller aggregates or ideally into primary particles by the dispersing operation. The charge control agent particles which exist after the dispersing in the binder should be smaller than 1 μm , preferably smaller than 0.5 μm , a narrow particle size distribution being of advantage. Action ranges which are optimum, depending on the substance, are found for the particle size, defined by the d_{50} value. Thus, for example, coarse particles (1 mm) sometimes cannot even be dispersed at all or can be dispersed only with a considerable expenditure of time and energy, while very fine particles in the submicron range present an increased safety risk, such as the possibility of dust explosion.

The particle size and shape is established and modified either by the synthesis and/or aftertreatment. The property required is often only possible by controlled aftertreatment, such as grinding and/or drying. Various grinding techniques are suitable for this. Air jet mills, cutting mills, hammer mills, bead mills and impact mills, for example, are advantageous.

The binder systems mentioned in the present invention are typically hydrophobic materials. High water contents of the charge control agent can either oppose wetting or promote dispersing (flushing). The practicable moisture content is therefore substance-specific.

The compounds according to the invention are characterized by the following chemical/physical properties:

The water content, determined by the Karl-Fischer method, is between 0.001% and 30%, preferably between 0.01 and 25%, and particularly preferably between 0.1 and 15%, it being possible for the water to be adsorbed and/or bonded, and for the content thereof to be adjusted by the action of heat up to 200°C and vacuum down to 10^{-8} mmHg or by addition of water or storage under defined atmospheric humidity conditions.

Surprisingly, the compounds according to the invention which contain one or more organic cations defined above show no particularly increased H₂O content (Karl-Fischer method) after storage at 90% relative atmospheric humidity and 25°C in a climatic test cabinet for 48 hours, while the analogous structured silicates with metal cations show significantly higher H₂O contents, sometimes several times that before the climatic storage.

The particle size, determined by means of light microscopy evaluation or laser light diffraction as defined by the d₅₀ value, is between 0.01 µm and 1000 µm, preferably between 0.1 and 500 µm, and very particularly preferably between 0.5 and 400 µm. It is particularly advantageous if a narrow particle size results from the grinding. A range Δ (d₉₅-d₅₀) of less than 500 µm, in particular less than 400 µm, is preferred.

The conductivity of the 5% strength aqueous dispersion is between 0.001 and 2000 mS, preferably between 0.01 and 100 mS. The compounds according to the invention contain both crystalline and amorphous contents.

The compounds used according to the invention, when incorporated into a toner binder, show a heat stability up to 200°C (no discoloration) in a thermal gradient test (Kofler test).

In electrokinetic surface potential determination by means of SCD (streaming current detection), the compounds according to the invention with the organic cations defined above surprisingly show significantly lower surface potentials (positive or negative sign) than the corresponding structured silicates with metal cations. On titration of these compounds with corresponding surface-active reagents to the zero point of the surface potential (SCD monitoring of the titration), significantly more surface-active reagent is needed for the compounds with metal cations than for the corresponding structured silicates with organic cations. This indicates a high stability of the salt bond between the structured silicate and organic cation.

The salts, employed according to the invention, of ionic structured silicates can also be combined with further charge control agents with a positive or negative control in order to achieve good charging possibilities in use, the total
 5 concentration of the charge control agents expediently being between 0.01 and 50% by weight, preferably between 0.05 and 20% by weight, particularly preferably between 0.1 and 5% by weight, based on the total weight of the electrophotographic toner, developer, powder or powder coating.

- 10 Possible further charge control agents are, for example:
 triphenylmethanes; ammonium and immonium compounds, iminium compounds;
 fluorinated ammonium and fluorinated immonium compounds, biscationic acid
 amides; polymeric ammonium compounds; diallylammonium compounds;
 arylsulfide derivatives, phenol derivatives; phosphonium compounds and
 15 fluorinated phosphonium compounds; calix(n)arenes, oligosaccharides linked in
 cyclic form (cyclodextrins) and derivatives thereof, in particular boron ester
 derivatives, interpolyelectrolyte complexes (IPECs); polyester salts; metal
 complex compounds, in particular salicylate-metal complexes and salicylate-
 nonmetal complexes, hydroxycarboxylic acid-metal complexes and
 20 hydroxycarboxylic acid-nonmetal complexes, benzimidazolones; azines,
 thiazines or oxazines which are listed in the Colour Index as pigments, solvent
 dyes, basic dyes or acid dyes.

- The charge control agents mentioned below, which can be combined individually
 25 or in combination with one another with the salts of the ionic structured silicates,
 are particularly preferred:
 triphenylmethanes, as described, for example, in US-A-5 051 585; ammonium
 and immonium compounds, as described, for example, in US-A-5 015 676;
 fluorinated ammonium and fluorinated immonium compounds, as described, for
 30 example, in US-A-5 069 994; biscationic acid amides, as described, for example,

in WO 91/10172; diallylammonium compounds, as described, for example, in DE-A-4 142 541, DE-A-4 029 652 or DE-A-4 103 610; arylsulfide derivatives, as described, for example in DE-A-4 031 705; phenol derivatives, as described, for example, in EP-A-0 258 651; phosphonium compounds and fluorinated phosphonium compounds, as described, for example, in US-A-5 021 473 and US-A-5 147 748; calix(n)arenes, as described, for example, in EP-A-0 385 580; benzimidazolones, as described, for example, in EP-A-0 347 695; oligosaccharides linked in cyclic form, as described, for example, in DE-A-4 418 842; polyester salts, as described, for example, in DE-A-4 332 170; cyclooligosaccharide compounds, as described, for example, in DE-A-197 11 260; inter-polyelectrolyte complexes, as described, for example, in DE-A-197 32 995. Surface-active ionic compounds and so-called metal soaps are furthermore suitable, especially for liquid toners.

Alkylated arylsulfonates, such as barium petronates, calcium petronates, barium dinonylnaphthalene sulfonates (basic and neutral), calcium dinonylsulfonate or dodecylbenzene sulfonic acid Na salt, and polyisobutylenesuccinimides (Chevrons Oloa 1200) are particularly suitable. Soylecithin and N-vinylpyrrolidone polymers are furthermore suitable. Sodium salts of phosphated mono- and diglycerides with saturated and unsaturated substituents, AB di-block copolymers of A: polymers of 2-(N;N)dimethylaminoethyl methacrylate quaternized with methyl p-toluenesulfonate and B: poly-2-ethylhexyl methacrylate are furthermore suitable. Di- and trivalent carboxylates, in particular aluminum tristearate, barium stearate, chromium stearate, magnesium octoate, calcium stearate, iron naphthalate and zinc naphthalate are furthermore suitable, especially in liquid toners. Chelating charge control agents (EP 0 636 945 A1), metallic (ionic) compounds (EP 0 778 501 A1), phosphate metal salts, as described in JA 9 (1997)-106107, are furthermore suitable. Azines of the following Colour Index Numbers: C.I.

Solvent Black 5, 5:1, 5:2, 7, 31 and 50; C.I. Pigment Black 1, C.I. Basic Red 2 and C.I. Basic Black 1 and 2 are furthermore suitable.

5 The structured silicates used according to the invention are incorporated homogeneously, for example by extrusion or kneading, bead grinding or with an Ultraturrax (high-speed stirrer) into the binder of the particular toner, developer, coating, powder coating, electret material or polymer to be separated electrostatically individually or in combination with one another or with further abovementioned charge control agents in a concentration of 0.01 to 50% by weight, preferably 0.05 to 20% by weight, particularly preferably 0.1 to 5.0% by weight, based on the total mixture. The compounds employed according to the invention can be added here as dried and ground powders, dispersions or solutions, presscakes, masterbatches, preparations, mixed pastes, as compounds absorbed from aqueous or non-aqueous solution onto suitable carriers, such as, for example, silica gel, or mixed with such carriers, TiO_2 , Al_2O_3 or carbon black, or in another form. The compounds used according to the invention can in principle also be added as early as during the preparation of the particular binders, that is to say in the course of polymerization, polyaddition or polycondensation thereof.

20 To prepare electrophotographic color toners, coloring agents, such as organic color pigments, inorganic pigments or dyestuffs, are added. The organic color pigments can be pigments from the group consisting of azo pigments or polycyclic pigments or mixed crystals (solid solutions) of such pigments.

25 Preferred blue and/or green pigments are copper phthalocyanines, such as C.I. Pigment Blue 15, 15:1, 15:2, 15:3, 15:4, 15:6, P. Blue 16 (metal-free phthalocyanine), or phthalocyanines with aluminum, nickel, iron or vanadium as the central atom, and furthermore triarylcarbonium pigments, such as Pigment Blue 1, 2, 9, 10, 14, 62, 68, Pigment Green 1, 4, 7, 45; orange pigments, such as, for example, P.O. 5, 62, 36, 34, 13, 43, 71; yellow pigments, such as, for

example, P.Y. 12, 13, 17, 83, 93, 122, 155, 180, 174, 185, 97; red pigments, such as, for example, P.R. 48, 57, 122, 146, 149, 184, 186, 202, 207, 209, 254, 255, 269, 270, 272; violet pigments, such as P.V. 1, 19, carbon black, iron/manganese oxides; and furthermore mixed crystals of C.I. Pigment Violet 19 and C.I. Pigment Red 122. The mixtures can be prepared in the form of the powders, by mixing presscakes, spray-dried presscakes, masterbatches and by dispersing (extrusion, kneading, roll mill processes, bead mills, Ultraturrax) in the presence of a carrier material in solid or liquid form (in water-based and non-aqueous inks) and by flushing in the presence of a carrier material.

If the coloring agent is employed with high water or solvent contents (> 5%), mixing can also proceed with assistance in the presence of elevated temperatures and by vacuum. The flushing operation can proceed in the presence or absence of organic solvents and of waxes.

Mixtures with organic dyestuffs are suitable in particular for increasing the brilliance, but also for adjusting the color shade. Preferred such dyestuffs which are to be mentioned are:

water-soluble dyestuffs, such as, for example, direct, reactive and acid dyes, and solvent-soluble dyestuffs, such as, for example, solvent dyes, disperse dyes and vat dyes. Examples which may be mentioned are: C.I. Reactive Yellow 37, Acid Yellow 23, Reactive Red 23, 180, Acid Red 52, Reactive Blue 19, 21, Acid Blue 9, Direct Blue 199, Solvent Yellow 14, 16, 25, 56, 62, 64, 79, 81, 82, 83, 83:1, 93, 98, 133, 162, 174, Solvent Red 8, 19, 24, 49, 89, 90, 91, 92, 109, 118, 119, 122, 124, 127, 135, 160, 195, 212, 215, Solvent Blue 44, 45, Solvent Orange 41, 60, 63, Disperse Yellow 64, Vat Red 41, Solvent Black 45, 27.

Dyestuffs and pigments with fluorescent properties, such as [®]Luminole (Riedel-de Haen) can also be employed, for example to prepare falsification-proof toners.

Inorganic pigments, such as, for example TiO_2 or BaSO_4 , are used in mixtures for brightening. Mixtures with effect pigments, such as, for example, pearlescent

pigments, Fe_2O_3 pigments (®Paliochrome) and pigments based on cholesteric polymers, which produce different color impressions depending on the angle of observation, are furthermore suitable.

- 5 The present invention also relates to an electrophotographic toner, powder or powder coating comprising 30 to 99.99% by weight, preferably 40 to 99.5% by weight, of a customary binder, for example a styrene, styrene/acrylate, styrene/butadiene, acrylate, urethane, acrylic, polyester or epoxy resin, or a combination of the last two, 0.01 to 50% by weight, preferably 0.05 to 20% by weight, particularly preferably 0.1 to 5% by weight, of at least one salt of ionic structured silicate and optionally 0.001 to 50% by weight, preferably 0.05 to 20% by weight, of a coloring agent, in each case based on the total weight of the electrophotographic toner, powder or powder coating.

- 15 The compounds described according to the invention can furthermore be applied to "free-flow agents" as an additional charge control element in suspended form or in a dry mixture. The compounds described according to the invention can also be employed for a "carrier coating".

EXAMPLES

- 20 In the following examples, parts denote parts by weight and percent denotes percentage by weight.

Preparation example 1

- 10 g of bentonite (pH 7-12) are dispersed in 300 ml of deionized water by means of stirring for 16 hours at 20°C. The suspension is then adjusted to a pH of 25 between 1.5 and 8 by means of dilute sulfuric acid, and thereafter 5.3 g of a 77% strength aqueous distearyldimethylammonium chloride solution (DSDMAC) are added to the bentonite suspension. The reaction mixture is subsequently stirred at 60°C for 4 hours and filtered with suction and the residue is rinsed several times with deionized water and then dried at 60°C in vacuo.

- 30 Characterization:

White to pale gray powder

pH: 8.4

Residual moisture content: 1.4 % (Karl-Fischer Titration)

5 $\tan \delta$ (1 kHz):0.78

 $\Omega \text{ cm: } 5 \cdot 10^8$

Crystallinity: > 70% (X-ray diffraction); numerous reflection peaks between 2 Theta 5 and 55° (main peaks: 3.5°; 6.6°; 19.8°; 23.7°; 24.4°; 27.7°; 35.0°; 38.3°; 54.0°).

Solubilities: insoluble in water, ethanol, acetone, n-hexane (< 10 mg/l).

Preparation example 2

15 10 g of a magnesium hydrosilicate (Optigel SH, "Hectorite") are dispersed in
400 ml of deionized water at room temperature for 2 hours.
6.0 g of an 80% strength aqueous distearylmethylbenzyl-/
distearyldimethylammonium chloride mixture (DSMB/DSDMAC) are then added
and the reaction mixture is stirred at 80-100°C for 30 minutes. The precipitate is
20 filtered off with suction, washed several times with deionized water and dried at
60°C in vacuo.

Preparation examples 3 to 28

No.	Preparation according to example	Structured silicate used	Organic cation
3	2	Hectorite	Fluorinated quat
4	1	Montmorillonite	Fluorinated quat
5	1	Acid bentonite	DSMB/DSDMAC
6	1	Acid bentonite	Fluorinated quat
7	1	Magnesium hydrosilicate	Protonated prim. amine (C _{16/18})
8	1	Magnesium hydrosilicate	Protonated primary amine (C ₈)
9	1	Alkaline bentonite	Cetyltrimethylammonium
10	1	Alkaline bentonite	Coconut alkyldimethylbenzylammonium
11	1	Alkaline bentonite	Didecyldimethylammonium
12	1	Alkaline bentonite	Dioctyldimethylammonium
13	1	Alkaline bentonite	Fluorinated quat
14	1	Alkaline bentonite	Triphenylmethane cation
15	1	Alkaline bentonite	Diallyldimethylammonium
16	1	Alkaline bentonite	Tetrapropylammonium
17	1	Alkaline bentonite	(R) ₃ N-CH ₃ R= (CH ₂) ₂ O-CO(CH ₂) ₁₁₋₂₁ CH ₃
18	1	Alkaline bentonite	C ₁₂ /C ₁₄ -Alkyldimethylbetaine
19	1	Alkaline bentonite	Sulfinato-Sulfobetaine
20	1	Alkaline bentonite	Trimethyltriazacyclononanium
21	1	Alkaline bentonite	Zn-salicylate 1:1 complex
22	1	Alkaline bentonite	Cetylpyridinium
23	1	Aqueous bentonite	Distearyldimethylammonium
24	1	Kaolinite	Distearyldimethylammonium
25	1	Magnesium hydrosilicate	Distearyldimethylammonium
26	1	Alkaline bentonite	Methylene blue
27	1	dto.	1-Methyl-1-stearyl-amidoethyl-

No.	Preparation according to example	Structured silicate used	Organic cation
			2-stearylimidazolinium
28	1	dto.	Methyl-bis(stearylamidoethyl)-poly(ethylenoxid)ammonium

Fluorinated quat: $R - CF = CH - CH_2 - N^+Et_2Me$

$R = C_5F_{11}$ to $C_{11}F_{23}$

5 Characterization of Preparation example 11:

White to pale gray powder

DTA: no decomposition up to 200°C

pH: 8.7

10 Conductivity: 0.09 mS/cm

Residual moisture content: 1.0% (Karl Fischer Titration)

SCD: $U = -150$ mV (10 ml of 0.5% strength suspension);
titration to $U = 0$ mV with 0.1 ml of 10^{-3} M Polydadmac
solution

15 $\tan \delta$ (1 kHz): 2.7

Ω cm: $6 \cdot 10^7$

Crystallinity: > 70% (X-ray diffraction); numerous reflection peaks
between 2 Theta 5 and 55° (main peaks: 4.9°; 9.7°;
19.8°;

20 23.6°; 24.9°; 29.9°; 35.0°; 45.3°; 54.0°)

Particle size distribution: $d_{50} = 26$ μ m, $d_{95} = 213$ μ m (laser light diffraction)

BET: 23.4 m²/g

Solubilities: insoluble in water, ethanol, acetone, n-hexane
(< 10 mg/l).

25

Characterization of Preparation example 13:

White to pale gray powder

DTA: no decomposition up to 250°C

pH: 5.0

5 Conductivity: 0.20 mS/cm

Residual moisture content: 1.6% (Karl Fischer Titration)

SCD: U = -210 mV (10 ml of 0.5% strength suspension);
titration to U = 0 with 0.22 ml of 10⁻³M Polydadmac
solution10 tan δ (1 kHz): 1.3 Ω cm: 6·10⁸Crystallinity: > 70% (X-ray diffraction); numerous reflection peaks
between 2 Theta 5 and 55° (main peaks: 6.0°; 18.3°;
19.8°; 24.5°; 30.7°; 34.9°; 38.3°; 43.4°; 54.0°)15 Particle size distribution: d₅₀ = 90 μ m, d₉₅ = 390 μ m (laser light diffraction)BET: 17.8 m²/gSolubilities: insoluble in water, ethanol, acetone, n-hexane
(< 10 mg/l).

20 Use Examples

Use Example 1

^{Sub 16} 1 part of the compound from Preparation Example 1 is incorporated
homogeneously into 99 parts of a toner binder (styrene/acrylate copolymer 60:40
25 ®Dialec S 309) in the course of 30 minutes by means of a kneader. The mixture
is subsequently ground on a laboratory universal mill and then classified on a
centrifugal sifter. The desired particle fraction (4 to 25 μ m) is activated with a
carrier which comprises magnetite particles of size 50 to 200 μ m coated with
styrene/methacrylate copolymer (90:10).

30

Use Example 2

SUB
A₂

~~sample 1, a poly
instead of the s
um coated wi~~

The measurement is carried out on a customary q/m measuring stand. By using a sieve with a mesh width of 45 μm , it is ensured that no carrier is carried along with the blown-out toner. The measurements are carried out at about 50% relative atmospheric humidity. The following q/m values [$\mu\text{C/g}$] are measured, depending on the duration of the activation.

Year	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	

The procedure is as in Use Example 1 or 2, the compounds listed below being
5 employed instead of the compounds of Preparation Example 1.

Use Examples 38 to 40

The procedure is as in Use Example 1, either 0.5, 2 or 3 parts of the compound from Preparation Example 1 being employed instead of 1 part.

5 Use Examples 41 and 42

The procedure is as in Use Example 2, 2 or 3 parts of the compound from Preparation Example 1 being employed instead of 1 part.

Exp. No.	Parts	q/m [$\mu\text{C/g}$]				
		5 minutes	10 minutes	30 minutes	2 hours	24 hours
38	0.5	- 17	- 19	- 15	- 6	
39	2	- 32	- 30	- 21	- 6	
40	3	- 36	- 31	- 23	- 14	
41	2	- 28	- 25	- 23	- 21	- 19
42	3	- 32	- 26	- 24	- 23	- 21

10

Use Examples 43 and 44

The procedure is as in Use Example 1, 1 or 5 parts of a coloring agent having an electrostatically positive intrinsic effect (C.I. Solvent Blue 125, see Comparison Example A) also being incorporated in addition to the 1 part of the compound

15 from Preparation Example 1.

No.	Parts of coloring agent	q/m [$\mu\text{C/g}$]				
		5 minutes	10 minutes	30 minutes	2 hours	24 hours
43	1	- 17	- 15	- 11	- 7	- 5
44	5	- 5	- 4	- 3	- 4	- 3

Use Examples 45 to 53

The procedure is as in Use Examples 1, 38 and 39, 5 parts of an organic pigment (carbon black [®]Mogul L, Cabot; [®]Toner Magenta EO2, Clariant (C.I. P. Red 122); [®]Toner Yellow HG, Clariant (C.I. P. Yellow 180)) additionally also being incorporated.

5

No.	Parts of compound from Preparation Example 1	Organic pigment	q/m [μ C/g]				
			5 min.	10 min.	30 min.	2 hrs.	24 hrs.
45	0.5	Toner Magenta EO2	- 16	- 14	- 10	- 8	- 5
46	1	Toner Magenta EO2	- 21	- 17	- 14	- 10	- 3
47	2	Toner Magenta EO2	- 22	- 21	- 16	- 7	- 5
48	0.5	Toner Yellow HG	- 21	- 21	- 19	- 13	- 8
49	1	Toner Yellow HG	- 24	- 24	- 21	- 11	- 6
50	2	Toner Yellow HG	- 29	- 26	- 22	- 13	- 8
51	0.5	Carbon black	- 15	- 15	- 12	- 8	- 6
52	1	Carbon black	- 20	- 18	- 15	- 13	- 9
53	2	Carbon black	- 22	- 20	- 16	- 12	- 8

Comparison Example A:

The procedure is as in Use Example 43, 1 part of C.I. Solvent Blue 125 but no charge control agent according to the invention being incorporated.

10

Duration of activation	Charging q/m [μ C/g]
5 minutes	± 0
10 minutes	+ 1
30 minutes	+ 3
120 minutes	+ 10
24 hours	+ 29

The pronounced positive triboelectric intrinsic effect of the blue coloring agent is clearly detectable.

5 Use Example 54

1 part of the compound from Use Example 1 was incorporated homogeneously into 99 parts of a powder coating binder ([®]Crylcoat 430), as described in the Use Examples mentioned above. Tribo-spraying of the powder (coatings) was carried out with a [®]TriboStar spray apparatus from Intec (Dortmund) with a standard spray tube and a star inner rod at maximum powder throughput with a spray pressure of 3 and 5 bar. The current intensity resulting from the electrostatic charging of the powder coating or powder was indicated in μA . The deposition rate was then determined in % by the difference in weight of the powder coating sprayed and that deposited.

15

Pressure [bar]	Current [μA]	Deposition rate [%]
3	3.9	40
5	5.3	48